Position Sensing Technologies in Automotive Applications

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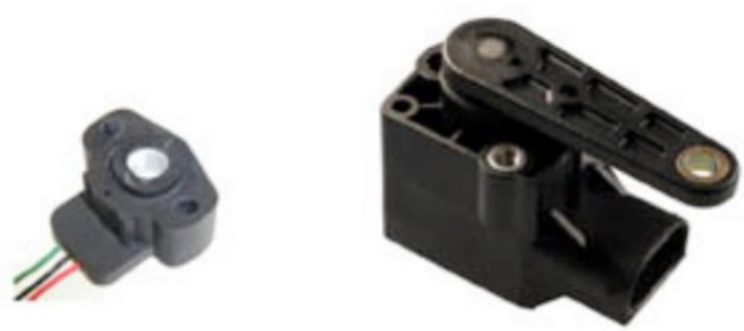
Automotive design engineers are continuously seeking components that offer performance and flexibility beyond those of conventional position sensing technologies. Further still are the requirements that these devices be versatile and adaptable to a wide range of applications. This demand has led to the need for devices incorporating the best design elements from conventional contacting and non-contacting sensor technologies.

With today's automobiles utilizing an ever-increasing amount of electronics and control systems, engineers face an increasingly difficult challenge incorporating these electronics into a car. Packaging space, power consumption and signal integrity are of primary importance to engineers. This is particularly true for sensors and other feedback electronics that are required to make cars safer, more fuel-efficient, and emissions friendly.

Electronic systems designers are always faced with the challenges of improving system resolution and signal quality in order to keep pace with newer controllers possessing greater speeds and I/O capabilities. Mechanical flexibility, environmental stability and signal integrity are key design features of any sensing technology used in today's vehicle environment.

One of the more demanding conditions for electronics is the range of operating temperatures they can experience. From cold environments of –40°C to temperatures in the engine compartment that can reach +150°C, sensors and their associated electronics are pushed to the limits of current materials. Future applications, like variable turbo chargers, will continue to drive even more demanding temperature extremes that can exceed +180°C. This requires sensor designers to develop material sets and packaging schemes to accommodate these demands.

At the same time, sensors must be capable of assuming a wide variety of mechanical configurations depending upon the needs of the overall system. Traditional sensing technologies like potentiometers and Hall effect devices may be packaged in either linear or rotary fashions. Each of these technologies has its strengths—potentiometers exhibit lower cost, mature technology, and mechanical flexibility while Hall effect exhibit low wear and good signal qualities—that can be leveraged depending upon the application. More advanced technologies, like inductive sensors, draw upon the strengths of these types of sensors to create a more robust sensing system.



Traditional sensing technologies include both potentiometer and Hall effect devices

Potentiometric technology is highly flexible in its ability to be designed for linear or rotary applications. By the nature of their design, potentiometers provide a ratiometric output signal proportional to the input voltage. However, this technology is somewhat limited by the nature of its analog output signal. While this signal can be electronically converted to a digital format, the conversion requires additional electronic components, which add cost to the sensor. Moreover, the resultant signal is still not a true high resolution digital format. With an increasing number of high-speed networks and

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communication buses being designed into modern vehicles, the requirement to specify an A/D converter for each potentiometer may be a disadvantage. Potentiometers are also a contact sensing technology, making them susceptible to wear-out from normal use and vibration over time. When a potentiometer's wear becomes pronounced, it can result in the generation of excessive noise in the signal. This can become an issue in direct feedback control loops.

Hall effect sensors typically produce an analog output signal that is conditioned by an ASIC for communication to the vehicle system. The ASIC may also be used to convert this signal directly to a digital format. Because Hall technology measures changes in magnetic Gauss levels, it requires very precise bearing systems in order to maintain its integrity. This requirement can somewhat limit this technology in terms of flexibility for mechanical packaging. These bearing systems also add some level of cost to the sensors. On the positive side, Hall effect sensors are non-contacting and therefore do not suffer the same degradation due to wear as potentiometers. Typically, in order to control the Gauss fields affecting a Hall effect sensor, they are designed with relatively short ranges of motion. In general, Hall effect sensors are designed with less that 180 degrees of rotational travel or less than 25mm of linear travel.

Recent advancements have been made in the development of new inductive sensing technologies that capitalize on the strengths of both potentiometric and Hall effect technologies. One such development encompasses a non-contacting sensing system consisting of two printed circuit boards with signal generation and sensing electronics at its core. Known as Autopad™, an inductive coupling is generated between the two printed circuit boards that is measured and transduced by an on-board ASIC.

TT electronics OPTEK Technology's Autopad™ sensing technology

Unlike Hall sensors, Autopad™ sensors are very compliant to misalignments in the X, Y and Z-axes, allowing the elimination of tight bearing systems. At the same time, the ASIC makes it a true digital sensor capable of producing a 12-bit PWM signal that can communicate directly with high-speed controllers. If necessary, this signal can also be converted into an analog format. OPTEK's Autopad™ is also capable of being designed into a multitude of physical configurations including rotary and linear versions. Rotary designs may be configured for systems with angular displacements up to a full 360 degrees. Linear sensors can be configured for linear displacements from 20mm to 200mm or more.

As automobiles evolve, design engineers are continuously calling for components that offer increased performance and flexibility. While traditional sensing technologies have their strengths, the development of inductive sensing technology offers solutions to the technical challenges and needs of today's demanding automotive electronics. The design flexibility of this type of sensing technology makes it a robust and cost effective solution for many automotive applications.

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